Proposal culminates years of effort by ANSI committee

At Last: Standards for Keyboards

by Joseph P. Ancona, Stuart M. Garland, and John J. Tropsa

Over the years, there have been increased applications of data communications, data entry and data processing terminals. Some of these take the form of crt displays, teleprinters and magnetic tape systems. Although different, they have one item in common—a keyboard.

In today's environment there is a high mobility of people within companies and within industries. In order to improve throughput between man and machine, manufacturers must provide standardized interfaces. Today, and in the foreseeable future, computer terminals will use typewriter-like keyboards as the principal link between man and machine. Further, "man" as defined will range from scientist to housewife to kindergarten student.

With this expectation, keyboard standardization is imperative if we are to optimize the benefits to society.

The keyboard arrangement on almost every typewriter in use in office or home is practically identical to the first developed by Christopher Sholes in 1873. Subsequent development of telecommunication and electric typewriters maintained his basic alphanumeric arrangement. Research consistently revealed that the over-riding criterion for continued use was the millions of people already familiar (and those trained annually in schools) with this arrangement.

Codes and keyboards

Keyboards associated with more recently developed equipment have as their primary function the generation of a coded signal. During the 1960s, the inadequacy of existing codes was highlighted by the increased sophistication of data communications, the widespread use of high speed electronic computers for data processing and information interchange and the international pressures for development of a common code.

Under the sponsorship of the Business Equipment Manufacturers' Association (BEMA), the American National Standards Institute (ANSI) worked with the International Standards Organization (ISO) to develop a standard code for information interchange. Worldwide, this code has been adopted as the International Standard Code for Information Interchange (R646). In the United States, it is known as the American Standard Code for Information Interchange—ASCII X3.4/68 (see Fig. 1).

Simultaneously there emerged a new technology for processing data; optical character recognition (OCR). This led to the development of the American Standard Character set for Optical Character Recognition (X3.17/1966).

The standard electric typewriter array (X4.7/1966) accommodated 81 of the 128 coded characters assigned in ASCII—and in OCR. All but the four abstract symbols had equivalents in ASCII. As a result, ANSI formed a committee of technical experts from user, government and manufacturing organizations

b_7 b_6 b_5 →					0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b_4 ↓	b_3 ↓	b_2 ↓	b_1 ↓	Column → / Row ↓	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	|
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

Fig. 1. ASCII Code Chart.

to develop standard alphanumeric keyboard arrangements accommodating the character sets of ASCII and OCR. The committee after several years of work has recently submitted the proposed standard to ANSI for final approval.

This standard, as are all ANSI standards, is developed for voluntary usage by the industry, the public, and the government. The means by which keyboards utilizing these arrangements are to encode the characters is not prescribed. This also applies to the physical characteristics such as size, shape, skew, and force displacement of the keys; such items are considered proprietary. However, it does define a contiguous character array and the relative location of the keys.

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In addition, the following criteria were adopted (not listed in order of priority) to reflect the needed transition from historically developed keyboard designs to a standard.

1. The keyboard arrangement should accommodate all 128 (graphic and control) characters of ASCII and all 57 characters of OCR.
2. The location of a specific character should remain unchanged in keyboard arrangements accommodating fewer than the complete set of characters.
3. The keyboard arrangements should:
   a. Facilitate simplicity of design,
   b. provide ease of operation,
   c. minimize operator training and retraining,
   d. be acceptable for international standardization,
   e. have maximum resemblance to present office electric typewriter, data communication and data processing keyboard arrangements,
   f. minimize the total number of graphic keys, and
   g. minimize the total number of function keys.

The need for human factors consultation and guidance was recognized early in the committee's deliberations. Experts from universities, industry, government and private consulting firms volunteered their time and talent. Constant communication was maintained. They reviewed the four row arrangement and assisted in the location of the most frequently used alphabetic, numeric and punctuation characters. This group agreed with the necessity of maintaining the traditional typewriter-like placement of characters.

Subsequent work within the International Standards Organization supported this decision by adopting the traditional "Sholes" arrangement for the 26 alphabet, 10 numeric, period and comma characters as the basis for a proposed international recommendation. The current international proposal is almost identical to the U.S.A. proposed standard.

The proposed standard

The proposed standard (x4A9/199B) provides two arrays for implementing the ASCII character sets. The two arrangements are identical in the placement of the alphabetics and numerics but differ slightly in the placement of some symbols. Further efforts to resolve this difference would have delayed the much needed standardization.

The first keyboard arrangement (Fig. 2) assigns all of the characters of ASCII in a typewriter-like array according to the logical bit pairing principle, and expected frequency of usage. The logical bit pairing principle specifically pairs characters on a key so that there is a single bit "shift."

The second keyboard arrangement (Fig. 3) duplicates the standard electric typewriter array X4.7/1966 and assigns the remaining graphic characters according to expected frequency of usage.

Inboard and outboard locations are provided for the control characters of the United States of America Standard Code for Information Interchange Character Set. The "inboard" control locations on bit paired keyboards shall be on the alphanumeric keys bit paired with the characters as shown in Fig. 4 (see page 36). The areas designated for "outboard" controls are located to the left and to the right of the alphanumeric area. The outboard control area is undefined in the exact placement of keys because it will vary with application. The character DEL (Delete) when used on a key by itself shall be located in the

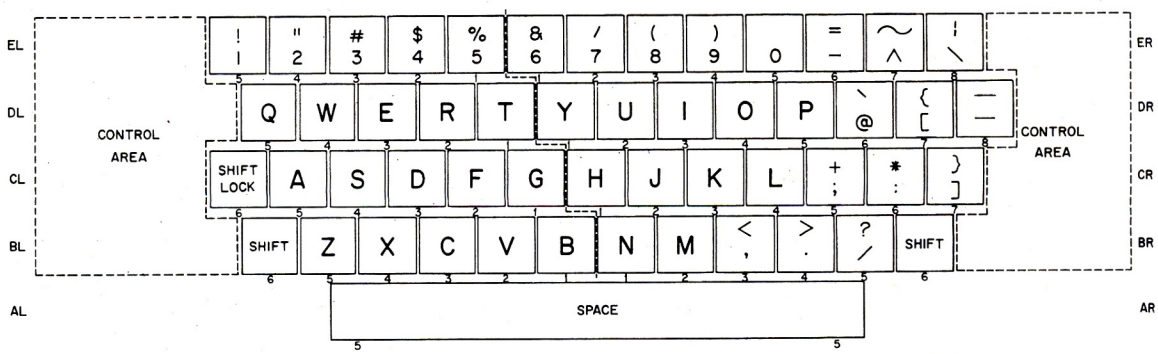


Fig. 2. Proposed U.S.A. Standard: Logical Bit Pairing.

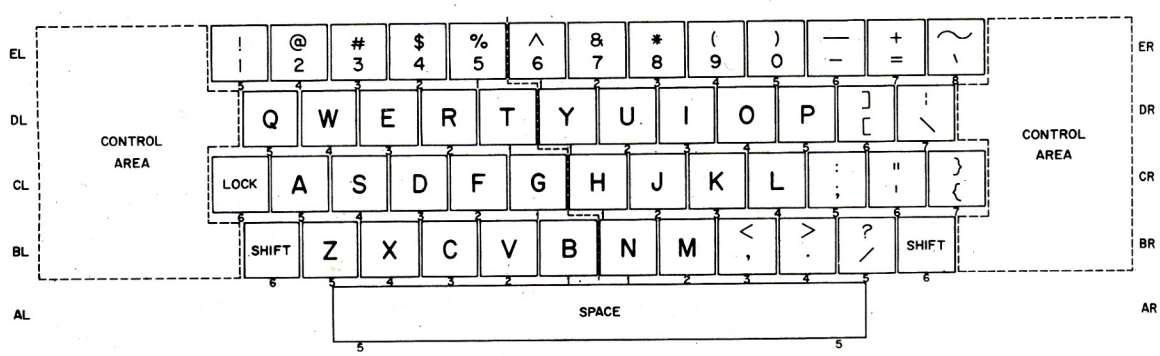


Fig. 3. Proposed U.S.A. Standard: Typewriter Pairing.

outboard control area.

Both arrays provide for the full implementation of the ASCII character set. It was, however, recognized that in some instances the complete character set is not required. Also, some equipment cannot accom-

NUL	@	DLE	P
SOH	A	DCL	Q
STX	B	DC2	R
ETX	C	DC3	S
EOT	D	DC4	T
ENQ	E	NAK	U
ACK	F	SYN	V
BEL	G	ETB	W
BS	H	CAN	X
HT	I	EM	Y
LF	J	SUB	Z
VT	K	ESC	[
FF	L	FS	\
CR	M	GS	]
SO	N	RS	^
SI	O	US	—

Fig. 4. Proposed U.S.A. Standard: Inboard Control Mode.

modate all of the keys in the array. Therefore, an orderly means of providing keyboard arrangements of fewer characters have been incorporated in this proposal.

Future program

Many problems still confront the committee in relation to keyboard standardization. Work will begin in the following areas:

Identifying and positioning.

1. Numeric clusters. Traditionally, numerics have been assigned to the top row of the keyboard. This has been satisfactory when an operator is engaged primarily in typing text with an occasional street address or date. Increasing the numeric content by 20%, 40% or 60% can alter the throughput significantly, hence the need for a more efficient array of the numerics. The questions are where and how? Where —inboard (as the key entry), or outboard (as in other devices)? How—according to the standard 10-key array, or as arranged in the widely-used keypunch, or in the new and widely-implemented "touch-tone" array?

2. Frequently used (outboard) control characters. BACKSPACE and TAB have a *fairly* consistent position assignment. CARRIAGE RETURN and LINE FEED locations have varied in the right hand outboard area. In some systems, they have been combined into a "NEW LINE" control. The use of other control characters are largely dependent on the terminal's function as part of a system. In some instances, not all control characters will be needed; which will be used most frequently, and in what position?

3. Control characters not now in ASCII or OCR, yet needed for new crt and key entry devices. Specific code assignments for XMIT, ERASE, ATTENTION, HOME and CURSOR arrows, used as local control on crt devices, do not exist. Similarly, there are no GROUP ERASE, CHARACTER ERASE and others needed for OCR document preparation. Is there a need to standardize on an array for the newer key entry devices, which also have many special control characters, such as ERROR RESET and LEFT ZERO following the traditional keypunch array?

Research.

We know that many so-called "dedicated" systems utilize special function symbols. While in the past these systems had restricted access and limited use, their worldwide availability is rapidly changing through time-sharing.

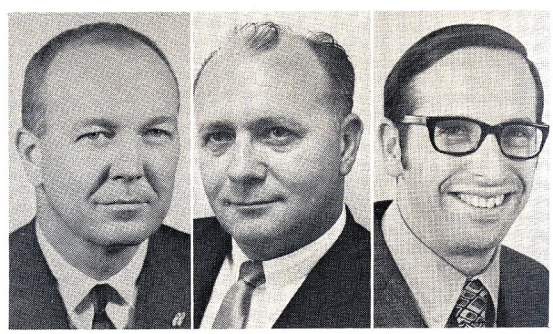
With the addition of control keys and expanded character sets, the same basic keyboard will be adapted to communications and direct processor entry. It has been estimated that, within several years, nearly a quarter of a million keyboards will be used for direct data processing through data communications networks.

A large proportion of operators will be exposed to keyboards serving functions, which several years ago were distinct, but which are being merged more frequently so that the three functions—local document production, communications, and direct processor entry—will become inseparable. Conservative indications are that, within a few years, there will be close to two million keyboard devices serving these three functions. With such a large number of keyboards, for the sake of consistency for the operator, standardization is an important consideration.

With such wide-spread usage, small changes in operator performance could result in a significant overall effect. If we were to postulate, conservatively, a two-hour-per-day use for the projected two million keyboard devices, the usage per year would total 500 million man-hours. Assuming a standard keyboard could be developed that would result in a half per cent increase in throughput and a half per cent reduction in error rate, a conservative estimate of effective savings would exceed two million hours per year in the United States.

It is rather obvious that the future program of work for this committee is indeed an important task.

Comments and suggestions relative to the proposed standard and future program of work are welcome and should be directed to the ANSI, 1430 Broadway, New York, N.Y. 10018. ■



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